Section 8
Wastewater Infrastructure Requirements

This section analyzes the capacity of the existing wastewater plants in the study area, as well as additional wastewater infrastructure requirements for existing and future conditions.

As discussed in Section 7, there are many options for wastewater treatment; however, not all of them are necessarily feasible for the study area physical, economic and social conditions. As a result of this diversity, it is necessary to conduct a screening process to identify those options that merit further consideration, and that would be useful for the identification of integrated alternatives. Similarly, it is important to sep in mind the there might be a significant similarity between some options at the level of detailed presented in a master plan. Furthermore, it is important to remember that the recommendations in the master plan will establish a future action frame that should be complemented with subsequent planning activities.

8.1 Wastewater System Evaluation

This section includes a brief summary of the conditions of the existing treatment plants, which are discussed in greater detail in Section 3. Wastewater flows generated in the study area are treated in five plants, four of which are operated by CESPT and are located in Mexican territory. The remaining plant is located in the United States and is operated by the International Boundary and Water Commission (IBWC). The following is a brief summary of each plant.

South Bay International Wastewater Treatment Plant (SBIWTP)

The SBIWTP is located in the United States and is operated by IBWC. This plant provides advanced primary treatment for 1,100 l/s of wastewater from the city of Tijuana. The effluent from the plant is discharged into the Pacific Ocean through an ocean outfall.

The treatment plant includes a chemical feed system, primary sedimentation tanks with flocculation and sedimentation, and a disinfection system.

The SBIWTP operates properly, although due to limitations inherent to this type of treatment processes, it does not comply with discharge limits established by the United States authorities. As described later, the U.S. Congress has ordered IBWC to take the necessary measures to support the construction of secondary treatment facilities.

For planning purposes, it is assumed that this plant will continue operating with a 1,100 l/s capacity and will provide treatment for wastewater generated in Tijuana.

San Antonio de los Buenos Plant

The San Antonio de los Buenos plant has a design capacity of 750 l/s, and is based on aeration lagoons. Currently, the plant is being improved by the addition of aerators and by dividing sedimentation lagoons. These improvements will increase the treatment capacity to an average flow of 1,100 l/s. The improvement works began in December 2001 and will conclude in March 2003.

The existing plant does not comply with the maximum discharge limits established by NOM-001-ECOL-1996 or with the Specific Discharge Conditions, as detailed in Section 3. The existing sludge management system is also inadequate. Nonetheless, it is expected that after improvements the plant will come into compliance.

For planning purposes, it is assumed that the improved plant will continue operating with a capacity of 1,100 l/s and that it will comply with the maximum discharge limits allowed by NOM-001-ECOL-1996.

Rosarito Plant

The Rosarito plant has a design flow of approximately 37 l/s. The plant consists of oxidation lagoons and does not comply with discharge limits established by the standard or with Specific Discharge Conditions.

Section 3 describes the improvements proposed for this plant. After improvements the average plant capacity will increase to 50 l/s and the plant will comply with the limits established in the specific discharge conditions.

San Antonio del Mar Plant

The San Antonio del Mar plant has a design capacity of 2.15 l/s. The plant consists of an activated sludge process in its extended aeration mode. The existing plant fully complies with the discharge limits.

For planning purposes, it is assumed that the plant will continue operating at a design capacity of 2.15 l/s.

Puerto Nuevo Plant

The Puerto Nuevo plant is located in the community of Puerto Nuevo, on the south side of Playas de Rosarito. The plant has a design capacity of 1.5 l/s. The existing plant operates deficiently. In order to reduce the existing contaminant load, it is recommended that plant improvements be made and a commercial discharge control program implemented.

For planning purposes, it is assumed that the plant will continue operating at a capacity of 1.5 l/s.

Table 8-1 summarizes the existing and future capacity of each of the existing treatment plants in the study zone.

Table 8-1 Existing Wastewater Treatment Plants		
Name	**Capacities**	
	Existing 2002 (l/s)	**After Improvement (l/s)**
SBIWTP	1,100	1,100
San Antonio de los Buenos (Punta Bandera)	750	1,100
Rosarito	37	50
San Antonio del Mar	2.5	2.5
Puerto Nuevo	1.5	1.5
Total	**1,891**	**2,254**

The capacity of the 5 existing plants will be considered as part of the baseline condition used to estimate additional wastewater requirements discussed in Section 8.3.

8.2 Wastewater Projects considered by CESPT in the short-term

The State of Baja California has negotiated a credit program with Japanese institutions for the construction of water and wastewater infrastructure for major cities in the state. With regards to wastewater, the construction of 4 wastewater treatment plants is being considered for the Tijuana and Playas de Rosarito area.

The new plants will treat wastewater by means of activated sludge at the capacities shown in Table 8-2. The table also shows the year in which each plant is expected to start operation.

Table 8-2 Capacity and Year in which the Japanese Credit Plants will Start Operations		
Name	**Capacity (l/s)**	**Start of Operations (year)**
La Morita	380	2005
Tecolote-La Gloria	380	2005
Monte de los Olivos	460	2005
Lomas de Rosarito	210	2005
Total Capacity	**1,430**	

The capacities of these plants will also be taken into consideration as part of the baseline condition used to estimate wastewater treatment capacity needs.

8.3 Additional Needs for Wastewater Treatment Capacity

Future wastewater needs were estimated based on a comparison of the existing treatment capacities, including the start-up of operations of the four Japanese Credit plants, and the projected wastewater generation. As was detailed in Section 6, the projections of wastewater generation takes into consideration demographic growth projections, as well as the expected growth for the number of industrial, commercial and governmental users. (See Section 4)

Wastewater generation projections were geographically distributed by sewer basin based on the geographic distribution of the population and by applying potable water use rates and the wastewater generation rates for each type of user. It was estimated that for the year 2023 the total flow of wastewater generated would be 5,213 l/s, excluding the contribution from the arroyos deliberately intercepted and sent to the San Antonio de los Buenos treatment plant. This flow will be distributed between the 38 basins included in the study area. These 38 basins make up two macro-basins: the Tijuana River Basin and the coastal basins.

As discussed in Section 6, the flow projections take into consideration not only the permanent population in the study area, but also the seasonal or transient population. This is particularly important in Playas de Rosarito, where the transient population is estimated at approximately 43,000.

The five existing treatment plants have a total capacity of 2,254 l/s, prior to improvements. The four plants being build by CESPT under the Japanese Credit are scheduled to start operating in 2005 and will have a capacity of 1,430 l/s. After rehabilitation and with the Japanese Credit plans there will be an installed capacity of 3,684 l/s.

Table 8-3 compares the projection for wastewater generation developed in Section 6 with the existing available treatment capacity in order to estimate the expected capacity deficit. It should be noted that the comparison should be done not only at a global level, but also for each one of the two main macro-basins.

Table 8-3
Summary of Wastewater Projections and Capacity Available for Wastewater

	Mean daily flow for 2023 (g/s; l/s)	Available capacity in base condition including WWTP from Japanese Credit (g/s; l/s)	Additional capacity required for 2023 (g/s; l/s)
Flow generated in the Tijuana River basin	4,482	3,044	1,438
Flow generated in the Coastal Basins (Tijuana and Playas de Rosarito)[1]	906	640	266
Total[2]	**5,388**	**3,684**	**1,704**

[1] Includes Matadero, Laureles and Playas Norte.
[2] The total flow includes an average of 46.23 g/s (175 l/s) of flow from arroyos, captured by the sewage system (see Section 6).

As shown in Table 8-3, the additional treatment needs for wastewater flow generated in the Tijuana River basin are 1,438 l/s, while the needs for flows generated in the coastal basin are 266 l/s.

A series of alternatives to satisfy additional wastewater treatment needs are identified in Section 9, which includes the construction of treatment plants within the Tijuana River basin as well as outside of it. Section 9 also details the capacity for each of the plants, based on the location of the basins that will feed them.

8.4 Wastewater Treatment Options

The following section discusses treatment options available to satisfy the sanitation needs of Tijuana and Playas de Rosarito. The evaluation of options takes into consideration wastewater discharge regulations, projected wastewater flows, operation and maintenance costs, reliability, and simplicity of operation and public acceptance.

8.4.1 Wastewater Discharge Regulations

Wastewater discharges into national waters are regulated by Mexican Official Norm (*Norma Oficial Mexicana*) NOM-001-ECOL-1996, which establishes maximum permissible limits for different types of receiving bodies. These limits are shown in Table 8-4.

Table 8-4
Maximum Permissible Limits for Basic Contaminants

Parameters	Rivers						Natural and Artificial Reservoirs				Coastal Waters						Soil			
(milligrams per liter, except when specified)	Agricultural irrigation use (A)		Urban public use (B)		Aquatic life protection (C)		Agricultural irrigation use (B)		Urban public use (C)		Fisheries, navigation and other uses (A)		Recreationa l (B)		Estuaries (B)		Agricultural irrigation use (A)		Natural wetlands (B)	
	P.M.	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**	**P.M.**	**P.D.**
Temperature º C (1)	N.A.	N.A.	40	40	40	40	40	40	40	40	40	40	40	40	40	40	N.A.	N.A.	40	40
Greases and Oils (2)	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25
Floating Matter (3)	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent	ab-sent
Settleable Solids (mg/l)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	N.A.	N.A.	1	2
Total Suspended Solids	150	200	75	125	40	60	75	125	40	60	150	200	75	125	75	125	N.A.	N.A.	75	125
Biochemical Oxygen Demand	150	200	75	150	30	60	75	150	30	60	150	200	75	150	75	150	N.A.	N.A.	75	150
Total Nitrogen	40	60	40	60	15	25	40	60	15	25	N.A.	N.A.	N.A.	N.A.	15	25	N.A.	N.A.	N.A.	N.A.
Total Phosphorous	20	30	20	30	5	10	20	30	5	10	N.A.	N.A.	N.A.	N.A.	5	10	N.A.	N.A.	N.A.	N.A.
Arsenic	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.2	0.4	0.1	0.2
Cadmium	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.5	0.1	0.1	0.2
Chrome	1	1.5	0.5	1.0	0.5	1.0	1	1.5	0.5	1.0	0.5	1.0	1	1.5	0.5	1.0	0.5	1.0	0.5	1.0
Copper	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4	6.0	4	6.0	4.0	6.0	4.0	6.0	4	6.0	4.0	6.0
Cyanide	2,0	3.0	1.0	2.0	1.0	2.0	2.0	3.0	1.0	2.0	1.0	2.0	2.0	3.0	1.0	2.0	2.0	3.0	1.0	2.0
Lead	0.5	1	0.2	0.4	0.2	0.4	0.5	1	0.2	0.4	0.2	0.4	0.5	1	0.2	0.4	5	10	0.2	0.2
Mercury	0,01	0.02	0.005	0.01	0.005	0.01	0.01	0.02	0.005	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.005	0.01	0.005	0.01
Nickel	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
Zinc	10	20	10	20	10	20	10	20	10	20	10	20	10	20	10	20	10	20	10	20

Note:
1. The permissible range in pH is 5 to 10 units.
2. Fecal coliforms should not be greater than 1000 NMP/100 ml, as an average and 2000 NMP/100 ml as a maximum.
3. Helminth Eggs less than or equal to 1.

In addition to the limits established by the norm, the San Antonio de los Buenos and Rosarito plants have Specific Discharge Conditions (SDC), which establish more stringent discharge limits than those established by NOM-001-ECOL-1996.

For planning purposes, it is assumed that plants in the study area should comply, as a minimum, with limits established for discharge to coastal water bodies for recreational use, which requires a monthly average concentration equal to or less than 75 mg/l for biochemical oxygen demand (BOD) and total suspended solids, among other parameters.

In addition to the national regulations discussed above, the master plan takes into consideration regulations based on the specific characteristics for the study area such as the presence of binational bodies of water, environmental protection agreements with the United States and requirements from potential funding sources.

An official norm for biosolids disposal generated in wastewater treatment plants was not available until the publication of the master plan, though a norm for the project PROY-NOM-004-ECOL-2001 exists, which establishes permissible maximum specifications and limits for contaminants.

According to the project norm the biosolids are classified as "excellent" and "good" based on its heavy metals content, and in Class A and B based on its pathogen content. The permissible maximum heavy metal limits are summarized in Table 8-5, while Table 8-6 presents pathogen limits.

Table 8-5
Permissible Maximum Limits for Heavy Metals in Biosolids According to the Project Norm PROY-NOM-004-ECOL-2001

Contaminant (in total form)	Excellent (mg/kg in dry base)	Good (mg/kg in dry base)
Arsenic	41	75
Cadmium	39	85
Chromium	1,200	3,000
Copper	1,500	4,300
Lead	300	840
Mercury	17	57
Nickel	420	420
Zinc	2,800	7,500

Table 8-6
Permissible Maximum Limits for Pathogens and Parasites in Biosolids According to the Project Norm PROY-NOM-004-ECOL-2001

Class	Pathogens		Parasites
	Fecal Coliforms (MPN/100 ml in dry base)	*Salmonella sp* (MPN/100 ml in dry base)	Helminth eggs/g in dry base
A	< 1,000	< 3	< 10
B	< 2,000,000	< 300	< 35

According to the project norm, the agency needs to document every two years that the biosolids are not corrosive, reactive, explosive, toxic or flammable before their disposal.

In order to take advantage of the biosolids in gardens, plant pots and green areas with direct human contact, among other uses, they must be "excellent", Class A. For the final disposal of biosolids, the maximum limits established in the two previous tables must be complied with.

Even when this norm is not in effect, it is assumed that it will be promulgated in the near future, therefore it will be considered a guide for the development of alternatives.

8.4.2 Discharge Quality Goals Recommended for the Master Plan

It is recommended that the discharge water quality goals established for the master plan take into consideration not only the requirements established by Mexican regulation, which should be considered as a minimum, but also the specific characteristics of Tijuana and Playas de Rosarito.

One of the basic principles of the master plan is that the effluent from wastewater treatment plants proposed in Tijuana cannot cross into the United States through the Tijuana River during the dry season. Therefore, the effluent from any treatment plant located in the Tijuana River basin should be directed to the Pacific Ocean in Mexican territory, or discharged through the ocean outfall located in the city of San Diego.

Any of these two discharge methods will have to comply not only with Mexican regulation, but also with any bi-national agreements or requirements from potential funding programs, such as the Border Environmental Infrastructure Fund (BEIF) managed by the North American Development Bank (NADBank).

As a result of these considerations, it was agreed during the Binational Technical Committee meetings to use treatment plants capable of complying with discharge limits shown in Table 8-7, for the planning process.

Table 8-7
Recommended Limits for Wastewater Effluent Discharge

Parameter	Limit NOM-001-ECOL-1996 (for coastal waters for recreational use) (mg/l)	Proposed limit (mg/l), Corresponds to the CPD.
Biochemical Oxygen Demand (BOD)	75	30
Total Suspended Solids (TSS)	75	30
Total Nitrogen	Not applicable	20

Even though the proposed discharge limits are more stringent than the norm, they can generally be met by secondary treatment plants. This water quality will give CESPT the flexibility for reuse and will increase the feasibility of using the ocean outfall in San Diego for the discharge and for obtaining grant funding from the NADB.

It is important to mention that some of the parameters regulated by NOM-001-ECOL-1996, specifically heavy metals, should be controlled at the generation sites (for example in industrial and commercial discharges), since the conventional treatment plants are not designed to effectively treat these types of contaminants. Section 16 expands on the industrial pre-treatment program and discharge control.

As previously described, the planning goal for biosolids is the project norm PROY-NOM-004-ECOL-2001.

8.4.3 Available Wastewater Treatment Options

Seven wastewater technologies appropriate for the conditions and discharge quality requirements of the study area were identified. This section briefly describes the main advantages and disadvantages of these options (see Table 8-6).

Natural systems

Natural treatment systems, such as aerated or facultative lagoons and artificial wetlands, provide secondary treatment with low energy requirements. Sedimentation as well as biological reaction on organic matter takes place in the lagoons, therefore investment costs are reduced and the operation is simplified. Sludge stabilization is reached in the lagoons. Disinfection may also be carried out in lagoons as a result of the sun’s ultraviolet radiation. The oxidation of organic matter is carried out in facultative lagoons through the natural transfer of oxygen from the atmosphere to the water column, while aerated lagoons use mechanical aerators or diffusers, which makes the process efficient and reduces land requirements at the cost of greater equipment and electric energy requirements.

This type of system is easy to operate and does not require highly specialized personnel. The requirements for sludge management are minimum, since sludge is only removed from the lagoons every two or three years.

Natural systems have a relatively low capital and operation and maintenance cost when compared to the mechanical systems described below.

Even though these systems have multiple advantages, they have two important limitations for the conditions of the study area. First, these systems require large land areas, which would make its construction difficult in urban areas or areas close to it. On the other hand, the quality of the discharges is governed not only by operation conditions, but also by meteorological conditions over which the operator does not have any control. As a result, there could be difficulties in consistently complying with the discharge limits.

Advanced Lagoons Systems

This type of system combines some of the attributes of the conventional lagoons mentioned above with mechanical systems components mentioned below. Though different potential configurations exist for these types of systems, two options have been previously considered for the upgrade of the SBIWTP including the Completely Mixed Lagoons System and the Integrated Advanced Lagoons System, which are briefly described below.

Both systems require grit removal, screening, pretreatment and primary sedimentation facilities. In the case of the Completely Mixed Lagoons System, mechanically aerated lagoons and a sedimentation lagoon follow these processes. Depending on the detention time of the system, the plant could require disinfection facilities. On the other hand, the Integrated Advanced Lagoons System consists of a lagoon with anaerobic digestion trenches, followed by completely mixed aerated lagoons and partially mixed aerated lagoons. Depending on the dimensions and configuration of the system, these lagoons could require a certain degree of mechanical mixing, though the purpose is to minimize the use of electrical energy.

These systems could include the recirculation of sludge, in order to increase the biomass concentration in the lagoons and improve treatment efficiency. These systems can produce an effluent quality similar to that commonly obtained with conventional activated sludge plants, with less equipment requirements and operational energy. These systems present less requirements for sludge management than some mechanized technologies, given that sludge is stabilized within the lagoons.

On the other hand, the lagoons generally have greater land requirements than mechanized technologies, which could present difficulties for the well-urbanized study area. These systems utilize natural processes to a large extent for the aeration and lagoons mixing, though not at the same level than the natural systems described previously. The operators will usually have a less control over the system than for the mechanized technologies.

Conventional activated sludge

Activated sludge technology is widely used around the world to produce effluent with quality similar to the limits established as a goal in the master plan. A typical treatment sequence for this type of technology consists of a pre-treatment process (grit and sand removal), followed by a primary sedimentation process, where a requirements for sludge management, which are stabilized in the secondary treatment of the liquid train. In addition, the treatment process does not require primary sedimentation, which reduces capital costs and requirements for sludge management. One important additional advantage for systems such as the one in Tijuana, where there are a considerable number of industrial users, is its capacity to attenuate peak loads of organic matter and in some cases, peak loads of toxic compounds.

A disadvantage to this type of system is the requirement for larger reactors and more land than other comparable technologies. Historically, extended aeration has been used for smaller plants than those required in Tijuana. However, in recent years plants with similar capacities to those recommended by this master plan have been constructed.

Combination of biofilters and activated sludges
The combination of these two technologies results in a high efficiency treatment with less operation and maintenance costs. In addition, the presence of a trickling filter allows for the reduction of maintenance and operation costs and for the attenuation of some peak loads.

The disadvantages to this process are a more complex operation than other options and a requirement for sludge stabilization.

Sequencing batch reactors
This process is an activated sludge method where aeration and sedimentation take place in the same reactor in which the aerators and mixers operate intermittently. This process is more cost-effective in terms of capital and operation and maintenance costs than other mechanical systems, while being a highly efficient treatment.

The main disadvantage of this system is the relative complexity of its operation and the requirement for relatively expensive and sophisticated automatic control systems.

Advanced primary treatment
The primary advanced treatment is a relatively simple process that consists of adding chemical reagents before sedimentation. This process does not have a biological reactor; therefore, the organic mater is only removed through assisted sedimentation.

The main advantage of this alternative is a low capital and operation and maintenance cost.

As a disadvantage, it will be difficult to meet the established discharge limits with this system. In addition, the use of chemical reagents increases the operation cost and requirements for sludge management.

Table 8-8
Available Wastewater Treatment Options

Option	Advantages	Disadvantages
Natural Systems (Aerated or facultative stabilization lagoons or artificial wetlands)	Á Lower capital cost Á Lower operation and maintenance cost Á Simple operation Á Low energy use Á Capacity to attenuate some peak loads and toxic substances Á Low sludge management requirements Á Certain degree of disinfection is accomplished in the lagoons by natural radiation of ultraviolet rays, even though not at the same degree than what would be obtained with additional processes (chlorination, ultraviolet) Á Adding artificial wetlands could increase the level of treatment and provide aesthetic benefits.	Á Lower effluent quality Á Discharge limits may be occasionally exceeded for TSS and ammonia due to the growth of algae (TSS) and accumulation of sludges (ammonia) Á High land requirements Á Potential for generation of odors and other nuisances (public acceptance) Á Low flexibility for operational control. The treatment efficiency is highly control by climate. Á There are seasonal variations in the treatment level. Á The lagoons have to be taken out of operation for sludge removal. Á Potential requirement for geomembrane (costs) Á The majority of the reuse alternatives would require additional treatment.
Mechanized Lagoons Systems	Á Fewer capital and operation and maintenance costs than mechanized technologies Á Simple operation Á Low energy usage Á Low requirements for sludge management Á A certain degree of disinfection is accomplished in the lagoons due to the natural ultraviolet radiation, though not at the same degree that could be obtained with additional processes (chloration, UV) Á Possible nutrient removal	Á High land requirements Á Potential generation of odors and other hindrances (public acceptance) Á Low flexibility for operations control. Treatment efficiency is highly controlled by the weather Á There are seasonal variations in the treatment level Á Lagoons need to be taken foe sludge removal out of operation Á Potential geomembrane requirements (costs) Á Potential discharge exceeding TSS and ammonia, due to algae growth and sludge accumulation
Conventional activated sludge	Á Lower land requirements than the lagoons and other mechanical options Á Higher removal of conventional contaminants (BOD, TSS) Á Potential to remove nutrients (nitrogen) Á Operational flexibility (control)	Á Investment costs greater than lagoons and other mechanical systems Á Operation and maintenance costs greater to lagoons and other mechanical systems Á Requires stabilization and drying of sludges Á Requires flow regulation for mitigation of peak loads and

Table 8-8
Available Wastewater Treatment Options

	• Technology commonly used and tested • Greater potential for water reuse • Less odor generation	toxic substances, which could inhibit the treatment process
Trickling filters (bio-filters) (synthetic media or rock)	• Lower capital costs than other mechanical options • Lower operation and maintenance costs than other mechanical options • Lower energy requirements than other mechanical options • Simple sequence operation of water treatment (but not sludge sequence treatment)	• The treatment efficiency may be somewhat limited to reach the 30/30 quality • The removal of ammonia would require larger filters • Sludge management facilities are required • Primary sedimentation is required, which results in the need to stabilize sludges, increasing the complexity of the system
Extended aeration (oxidation ditch)	• High treatment efficiency • Simple and flexible operation compared to other mechanical options • Less sludge generation, since sludge is stabilized in the aeration tank • More flexibility to mitigate load variations • May be used without primary sedimentation	• Longer retention time than other mechanical technologies, which requires larger tanks • Major land requirements than other mechanical technologies • Usually uses low efficiency surface aerators • Have been historically used for relatively small flows
Combination of trickling filters and activated sludge	• High treatment efficiency • Less operation and maintenance costs than other technologies • The biofilters mitigate variation in load and toxic substances for activated sludges	• Primary clarification is required, which results in the need to stabilize the sludge • Less operational flexibility and more complex than the activated sludges only • More loss of hydraulic load through the process
Sequencing batch reactor	• High treatment efficiency • Less operation and maintenance costs than other technologies – the whole treatment process is carried out in one reactor only • Greater flexibility to adjust to changes in discharge limits • Can be used without primary sedimentation	• Requires automatic controls • Flow regulation is required to mitigate variations in loads and toxic substances • Susceptible to the accumulation of greases and scum • Have been historically used for relatively small flows • Could require the over dimensioning of disinfection works based on the decanting rate
Advanced primary treatment	• Less investment cost than other technologies • Less operation and maintenance cost than other technologies	• Less treatment efficiency than secondary treatment technologies • Operation costs increase by adding chemical compounds • More sludge management requirements

8.5 Prioritization of Wastewater Option Used for Planning Purposes

The previous section describes some of the advantages and disadvantages of the main options for wastewater treatment within in the study area. One of these options will be used for planning purposes and cost estimating for the alternative analysis. Once an alternative has been selected and the master plan concluded, an in-depth evaluation of the treatment technologies can be carried out to select the most adequate treatment option given the site's specific conditions, capacity required, cost and treatment requirements.

The final decision as to what technology to use will depend on specific site conditions and water quality of the study area, factors unknown at this moment. However, for alternative comparison purposes, specifically with regards to cost comparison, activated sludge is used for all the alternatives. The other components of each alternative, such as conveyance infrastructure, will be the ones to determine the differences between alternatives.

Conventional activated sludge will be used for the purpose of this master plan. Activated sludge is widely used to obtain a quality effluent similar to that required by discharge limits established for this study. The cost estimates for all the alternatives will be made based on this type of technology. During subsequent phases to the planning process, this technology should be reconsidered based on site-specific requirements.

Sludge generated in this process requires stabilization before its use or disposal. Aerobic digestion is assumed for planning purposes, which in general terms consists of a thickening process followed by an aerobic reactor and a drying process, as well as chemical conditioning.

Some of the main advantages of aerobic digestion are the minor concentration of DBO in the decant, production of biologically stable and odor free sludge, greater recovery of fertilized properties, simple operation and low operational cost. On the other hand, the main disadvantages are related to the energy requirements for the oxygen supply, as well as the dependence of the temperature process, location and reactor materials.

Other sludge treatment options, such as composting, can be evaluated at a later time. Notwithstanding, the financial feasibility of a composting program will greatly depend on the existing market for the final product.

8.6 Identification of Potential Sites for the Construction of Treatment Plants

Cost estimates for the wastewater collection and conveyance infrastructure depend on the general location of the treatment infrastructure. Therefore, the general locations of the plants must be established.

In this section, the factors considered in the identification of potential sites when locating treatment plants are presented. Several engineering and planning criteria were used for the development of the master plan. Initial site determination involved reviewing documents in the office, and making field visits to the potential pre-determined sites. The precise location of the site will be studied during later stages, like the elaboration of facilities plans and final designs. These stages will define, among other things, the specific treatment technology. The specific treatment technology is a crucial element when choosing a parcel of land for the construction of a WWTP, since the land requirements can be significantly different depending on the selected processes. The future project may use a different technology treatment process than that used in the master plan for cost estimates.

In the subsequent phases, with detailed field studies (geological, topographical, seismic vulnerability, analysis of the quantity and quality of wastewater), the choice of treatment type and the land acquisition costs, the exact location of the plant will be available.

The identification of potential sites was first done in the office, taking into account the land availability, the topographic characteristics of the study area, the latest surveying information, the location of the existing and future contributing areas, the amount of the expected wastewater flows, and the placement of the existing wastewater collection and treatment infrastructure proposed as part of the Japanese Credit program.

The review in the office included the evaluation of existing development plans for each one of the municipalities. The goal was to find sites predetermined for future WWTPs within these existing plans. After reviewing the assembled information, the potential sites were identified on maps for later confirmation through field visits with staff from the *Subdirección de Saneamiento* (Sanitation Subdepartment). The field visits were made in the municipalities of Playas de Rosarito and Tijuana, Figure 8-1.

Municipality of Tijuana
Within the municipality of Tijuana, six potential sites were identified for the construction of treatment plants required under this master plan:

Arroyo Alamar Site 1
This site is located east of the city of Tijuana on the left (south) bank of the Río Alamar, 500 meters before the toll booth on the highway to the city of Tecate. The altitude of this site is 86 meters above mean sea level. To get water to this point it would be necessary to pump from the confluence of the Río Tijuana and the Río Alamar, a point where the waters coming from the discharge upstream of both river basins would be intercepted.

Arroyo Alamar Site 2
This site is located east of the city of Tijuana, approximately six kilometers after the toll booth on the highway to the city of Tecate. The area is located on the north side of

the highway. Its elevation is approximately 200 meters above sea level. The area that it would service would be the same as for Alamar Site 1, with the exception that in this case, the conveyance requirements would be twice the distance required for the first site and the unevenness of the land would be harder to overcome.

Arroyo Alamar Site 3

This site is located on the left (south) bank of the Río Alamar, approximately two and a half kilometers before the toll booth on the highway to Tecate.

This site would service the same area of the city of Tijuana set out in the two previous sites, but the difference is that this site is located on the edge of the urban sprawl of the city, therefore there would be less energy required for pumping water to the WWTP and less infrastructure requirements would be needed. The site is 80 meters above sea level.

Arroyo Alamar Site 4

This site is located north of the Tijuana and Alamar rivers limits and south of the Tijuana international airport, between Camino al Aeropuerto Street Upward and Camino al Aeropuerto Street Downward. Figure 8-1 indicated the location of the proposed site.

In the future, this area is expected to have industrial construction by the landowners. Its dimension is not sufficient for the construction of a plant with the required characteristics and capacity. Given the location, sludge transportation could represent great risks, considering its closeness to the center of Tijuana. Similarly, the management of great quantities of reactives, such as chlorine, constitutes greater risk than in other sites.

Matanuco Site

This site is located on the southern side of the federal highway to Tecate and within the urban sprawl of the city of Tijuana, past the Abelardo L. Rodríguez reservoir, near the National Railroad tracks. Given its location, this site would treat the wastewater generated in the southern Matanuco basin, which would arrive to the plant vía gravity. The elevation of this site is 100 meters above sea level.

Coastal Basin Site (San Antonio de los Buenos)

This site is located next to the San Antonio de los Buenos WWTP. The elevation of this site is 112 meters above sea level. This site would treat water that will be generated in the future in the basins of the coastal area and the high areas of western Tijuana.

Municipality of Playas de Rosarito

In the municipality of Playas de Rosarito, seven potential sites were identified for the construction of treatment plants. Two of them are in the urban area and the rest south of the city in towns located on the coastal basins.

Regional Coastal Site (Rosarito)
This site is located north of the urban area of Playas de Rosarito, on the eastern side of the highway from Tijuana to Ensenada. This plant would receive wastewater generated in the basins of the Río Tijuana not serviced by the International, San Antonio de los Buenos or Japanese Credit plants. Water would be conveyed to this site by means of a tunnel and force main. This site is 25 meters above sea level.

Rosarito I Plant Expansion
The expansion of the Rosarito I plant would treat wastewater generated in the Rosarito and Guaguatay basins. The elevation of this site is 52 meters above sea level.

Popotla Site
This site is located in Popotla on the eastern side of the federal highway from Tijuana to Ensenada. This plant would treat wastewater generated in the Sin Nombre, Playa Encantada, and El Morro basins that comprise the southern area of the urban area of Playas de Rosarito, Popotla and Calafia. The site is 15 meters above sea level.

Puerto Nuevo Site
This site is located north of the town of Puerto Nuevo, on the western side of the federal highway from Tijuana to Ensenada. This plant would treat the water generated in the Paraiso basin and in Puerto Nuevo, as well as from other communities and housing developments located in this coastal basin. The site is located 15 meters above sea level.

Mesa del Descanso Site
This site is located on the eastern side of the Tijuana – Ensenada highway near the town of Mesa del Descanso and is 60 meters above sea level.

The wastewater that would be treated at this site would originate in the Mesa del Descanso and El Descanso basins. The latter basin is where the town of El Descanso is located. This site is also favorable for the construction of a pumping plant if in later phases it is determined that pumping wastewater to one of the other proposed plants is preferable.

La Misión Site (Santa Anita)
This site is located southeast of the town of Santa Anita, some 500 meters from the course of the stream that discharges into the ocean and on its right (north) bank. This site is 15 meters above sea level.

This site would be able to treat wastewater generated in the town of Santa Anita and the houses located along the coastal area within the La Misión basin, belonging to the municipality of Playas de Rosarito.

Figure 8-1 shows the location of these potential sites.

Selection of potential sites

For the development of alternatives the following selection criteria for the proposed sites were as identified:

- Availability of land for treating the projected flow for the year 2023 and possible expansion
- Ease of construction
- Topography
- Geology
- Risk level
- Wastewater accessibility
- Availability of land for the construction of small pump stations to convey water to the treatment plants from the low points
- Land use
- Possibility of conveying wastewater to the WWTP by gravity
- Location of the main existing and future collectors
- Ease of construction of the main feeding the WWTP
- Possibility of urbanization in the short-term
- Feasibility of construction and future access to the WWTP site for the transport of equipment and materials
- Location of the site in relation to flooding areas
- Ease of sludge transport
- Location of the potential sites for sludge disposal (considering the Punta Bandera plant and a new site near Tecate as potential sites)
- Current and future land use
- Possibility of discharge to natural surface run-off channels
- Feasibility of construction of discharge lines
- Disposal points for treated water

- Feasibility of construction for a tunnel to convey wastewater to the plants located in the coastal area, and

- Possibility of water reuse in green areas and industry

Of the twelve previously described sites, four were rejected and the eight remaining sites were left for evaluation of the global alternatives.

The rejected sites were:

Alamar 1
The topographic conditions of the site were not suitable for the construction of a treatment plant and the area available was not sufficient. At least 8 hectares are needed for an activated sludge plant with a capacity of 1.5 m^3/s. However, this site had only 3 usable hectares.

Alamar 2
The distance between the point of the wastewater collection and the location of the proposed site ruled this option out. In addition the hydraulic head that needs to be overcome is too high. The water would have to travel approximately 18 kilometers and overcome a hydraulic head of around 300 meters.

Alamar 4
There are industrial structures on this site. In addition, it does not have sufficient area for the construction of a plant with the characteristics and capacity required. The site also has some safety issues. Due to its proximity to the center of the city of Tijuana, the transport of sludge could pose major risks. Likewise, the handling of reagents, such as chlorine, in large quantities would create a greater risk than other sites.

Matanuco
The Japanese Credit WWTPs of Monte los Olivos and la Morita are planned to be built on this site in the short term. Because of this, the site was ruled out for the master plan. Since La Morita WWTP site has land for expansion, it was decided that is was better to build the expansion on this land and to pump water from the Matanuco Sur basin, considering that the land is not significantly (20 m) uneven.

Sludge disposal sites
Sludge generated in the SBIWTP and the San Antonio de los Buenos plant are disposed of in constructed cells for this purpose inside the plant's property. Currently, there are three storage cells constructed in addition to five project cells. Jointly, the eight cells will have sufficient capacity to store sludge generated in these two plants, in addition to sludge produced in the four Japanese Credit plants, during the next 20 to 30 years, according to the projections of "Study of Sludge Management, Treatment and Disposal Produced in the Binational Treatment Plant of Municipal Wastewater with a Capacity of 1,100 l/s"

The sludge is received in a dehydrating unit, consisting of a concrete slab with drainage system for the collection of leachate, which is sent to the plant influent through gravity. The sludge remains in these slabs approximately 20 days, therefore increasing the solids content approximately 30 to 50 percent. The sludge is sent to the storage cells from the dehydration slabs.

Currently, these cells have been approved only for the SBIWTP and San Antonio de los Buenos sludge disposal, but it is expected to be able to receive the sludge form the Japanese Credit plants in the future.

It is recommended, as a phase after the master plan, that a more detailed feasibility study for the construction of a site for sludge disposal produced by the proposed. One of the preliminary options considered is the construction of a site east of Tijuana close to the road toward Tecate. This site will conveniently serve a regional plant located in the Tijuana river basin. The feasibility of constructing a disposal site for the plants located in the municipality of Playas de Rosarito must be evaluated.

8.7 United States Public Law Plant

On November 6th, 2000, the United States Congress enacted Public Law 106-457 Act, Estuaries and Clean Waters Act of 2000, which President Clinton signed into law. Title VIII, entitled Tijuana River Valley Estuary and Beach Cleanup, states that subject to the negotiation of a new treaty minute, the United States International Boundary and Water Commission (USIBWC) is authorized to take the necessary measures to provide secondary treatment in Mexico of up to 50 million gallons per day (mgd) (2,190 l/s) of: 1) 25 mgd (1,095 l/s) of advanced primary effluent of the South Bay International Wastewater Treatment Plant (SBIWTP) and 2) of additional wastewater generated in Mexico. Additionally, the Public Law plant could provide 25 additional mgd (1,095 l/s) of secondary treatment in Mexico subject to the results of the comprehensive plan. The secondary effluent from the Public Law facility could be reused in Mexico or the United States (after additional treatment) or discharged through the San Diego South Bay Ocean Outfall. Under the Public Law, the facility would be a privately constructed and owned wastewater treatment facility located in Mexico, which would then be financed under a twenty-year contract with the USIBWC. This contract would allow the owner of the facility to recover the costs associated with the development, financing, construction, and operation and maintenance of the facility.

The Public Law also directs the USEPA to develop the comprehensive plan with stakeholder involvement to address transborder sanitation problems in the San Diego-Tijuana border region. As stated above, the only determination that the master plan will make with respect to the Public Law facility is whether the facility should provide capacity in addition to the 50 mgd identified in the Public Law. The master plan will not assess the feasibility of the Public Law facility, as that determination is given to the USIBWC and Mexico under the Public Law. It is also important to note that the Public Law does not provide specific details on a significant number of infrastructure-related characteristics of the Public Law facility (e.g. the location of the plant). For this reason, the master plan has made a series of assumptions in this regard, which were discussed and approved by the project's Technical Committee. These assumptions, regarding infrastructure characteristics and cost allocation, are presented in Appendix P. It should also be noted that these assumptions were made only for purposes of the master plan and do not foreclose specific treatment technologies, locations, or other characteristics of a Public Law facility which may be subsequently agreed upon.

Thus, the master plan, which includes an analysis of the long term water and wastewater needs of the region, will identify options to meet those needs and make recommendations for preferred options for additional sewage treatment capacity for present and future flows.

As presented in sections 9 and 12, regarding the Public Law facility, the master plan will determine if the size of the Public Law facility should be greater than 50 mgd (and up to 75 mgd). The master plan will also analyze all of the top-ranked alternatives with and without the Public Law facility. In other words, the master plan will allow any Public Law facility that is implemented by the USIBWC and Mexico to be substituted for the Mexican facilities that will be included in the recommended alternatives.